

Occupational Noise Pollution and Hearing protection in selected industries

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ABSTRACT

The use of technology in industries is ever increasing. With the introduction of this technology come new safety and human performance concerns. Hearing loss caused by industrial noise has been recognized for many years, and protection of employee hearing has been made mandatory by governmental agencies. This paper presents an investigation of occupational noise exposure and Personal hearing protective devices (PHPD) in selected industries in the south-eastern Iran. A questionnaire has been used to collect data for workers with high noise exposure and Personal hearing protective devices (PHPD). The subjects were 354 industrial workers exposed to noise pressure levels greater than the action level defined in Iranian legislation (85dB (A) 8h/d). The results of this study indicated that only younger workers with minor professional experience and with high educational background are used PHPD to protect and preserve their hearing. The finding of this study shows that approximately 75% of the workers with age 18-36 reported the use of personal protective Devices at all the time, and 73% of workers with age more than 46 years old reported that they had never used them PHPD, even though it was mandatory in their workplaces. Statistical data show that, the percentage of male workers (82) with age more than 37 years old having headaches at workplace are higher than female (3.4) with the same age groups. A noise training and education program must be developed for industrial employees in order to protect them from hazardous noise pollution. Employers must play an important role in promoting the regular use of Personal hearing protective devices. Noise level in work areas must be considered in the early design of Hearing Conservation Program.

Key words: Noise, PHPD, Occupational noise, Safety and health, Hearing conservations programs

INTRODUCTION

The use of technology in industries is ever increasing. With the introduction of this technology come new safety and human performance concerns. As far back as 1970, the U.S. government has been concerned about safety issues in industries and as such developed the Occupational Safety and Health Administration (OSHA). All working conditions must be safe and healthful. Industries must furnish safe and healthy working conditions for all employees [1].

The general effect of noise on the hearing of workers has been a topic of debate among issues [2, 3, 4] for a number of years. Regulations limiting noise exposures of industrial workers have been instituted in many places [5]. For example in the US, the occupational Noise Exposure Regulation states that industrial employers must limit noise exposure to 8-hour time-weighted averages of less

than 90 dBA. Some companies pay very little attention to protecting the hearing of their worker [6].

Although Personal hearing protective devices (PHPD) are theoretically defined as a temporary solution, due to some economics and applicability issues, they are widely employed as the only measure against noise exposure [7]. However, it is also well known that failure to wear hearing protectors 100% of the time when hazardous noise is present will dramatically reduce PHPD effectiveness. Therefore, it is important that Personal hearing protective devices should be available in high-noise workplaces, but it is also essential that workers are aware of the need to use PHPD. Moreover, and despite the report of an increase in PHPD sales, the occurrence of NIHL has also increased, which could be due to the non-effective use of HPD [7], i.e., if Personal hearing

protective devices were used effectively the opposite trend of NIHL occurrence would have been registered.

Hearing protectors are not worn by many workers because of discomfort, interference with communication, etc. [8]. Workers are generally not motivated to do anything about noise at work because noise injury and the accompanying occupational hearing loss (OHL) occurs gradually, is not visible and has an uncertain time course in individuals [9, 10]. People who develop a noise injury are typically unaware that their hearing is affected until the loss is quite significant [11].

Brady [12] indicated that the way workers perceive the risk of noise exposure could play an important role in their safety behavior, namely in the use of Hearing Protection Devices. OSHA [13], suggested all workers must wear hearing protection devices if a noise dose is above 100 percent (time-weighted average (TWA) 90 dBA). In the same year, the US Environmental Protection Agency [14] estimated that more than 9 million US workers were occupationally exposed to daily noise levels above 85 dBA. OSHA [14], estimated that 7.9 million US workers in the manufacturing sector were occupationally exposed to daily noise levels at or above 80dBA. About 11 million workers in the US were exposed to potentially hazardous noise levels in the workplace [15].

Individual risk perception is a critical antecedent of risk behavior [16, 17]. The way in which workers perceive their exposure risks can be an important input for a better understanding of risk management, and ultimately, to their own safety [18]. Personal factors may also influence the success of hearing loss prevention programs. A number of studies have demonstrated that the use of hearing protectors is significantly affected by perceived Self-efficacy, noise annoyance, perceived barriers to and benefits of hearing protector use and Perceived susceptibility to hearing loss [8, 19].

The objective of this study was to investigate the associations between noise exposure and the use of Personal hearing protective devices.

MATERIAL AND METHODS

Subjects

The current study consisted of 5 different industrial companies, metal fabrication, textile, food, beverage and wood industries. These industries were selected taking into consideration the need to comprise different industrial environments. Subjects were 300 (85%) male and 54 (15%) female. Table 1 displays the age, educational background and year workers were working with the current industries. This study was carried out among industrial workers. Research was carried out in five different industries during 2006-2007. These

industries were located in Kerman, south-eastern in Iran.

Questionnaire

The aims of this study were to analyze the associations between noise exposure and the use of Personal hearing protective devices (PHPD).

Table 1: Gender, Age, Educational background and years with industries

	N	%	Mean
Gender			
Male	300	85	43.16
Female	54	15	15.9
Age (year)			
Less than 20	10	3	7.74
20-36	102	29	64.19
37-46	124	33	25.06
>46	118	33	25.06
Education Background			
Less than 6 Grade	160	45	77.63
6-10	120	34	48.62
10-12	54	15	17.55
>12	20	6	8.82
Years with Industries			
Less than 3	50	14	8.51
3-6	68	19	23.33
6-10	106	30	92.3
>10	130	37	85.30

For this purpose, and considering the literature review, four type questionnaires were developed, which is consisted the "Knowledge about noise" (this part had 5 items), "Knowledge about personal hearing protective devices" (this section had 4 items), "self efficacy" (this part had 5 items) and "health and safety" (this part had 3 items). This questionnaire had a 5-point Likert scale for most items (e.g., "Exposure to high noise levels can be dangerous for my hearing" rated from 'Strongly agree', to...'strongly disagree'). Space was provided for any comments that the respondent may have wished to make.

Noise levels

Daily noise exposure levels were determined for all workers in their different workplaces and industries by using an integrating sound level meter (Bruel and Kjaer model 2260) and noise dosimeters (Bruel and Kjaer model 4436). The selection of workers was based on noise levels, which should be higher than the action level of daily occupational noise exposure defined in Iranian legislation (85dB (A)) for 8h/d, according to [20].

RESULTS

Demographic data (Industrials respondents, noise exposure level)

The study included 354 respondents, 85% male and 15% females and the selection of workers was based on noise levels, which should be higher than the action level of daily occupational noise

exposure defined in Iranian regulations (85dB (A)), and ACGIH [21], according to [20] (see table 2). Table 3 displays the numbers of workers in different industries with minimum and maximum age.

Questionnaire

The questionnaire used had 17 items to which participants assigned a rating using a 5-point "strongly agree" to "strongly disagree" scale for the first 14 items and a 5-point "always" to "never" scale for the remaining 3 items. A reliability analysis (Cronbach's alpha) was performed on all 17 items for the 354 subjects that completed the questionnaire during the study. The alpha value of the 17 items was 0.68, which is considered to be acceptable, as suggested in Greenspoon and Saklofske [22]. By removing items with poorer item-total correlation, a subset of ten items with very good overall reliability ($\alpha = 0.76$) was obtained (see table 4).

Table2: Daily noise level

Daily noise level exposure level (dBA)	N	
	Male (%)	Female (%)
86-90	25 (7)	10 (3)
91-95	175 (49)	29 (8)
>96	10(29)	15 (4)

Table 3: Demographic variables (sample companies, N=354)

Industries	Age		
	N	Min	Max
Metal fabrication	100	18	55
Textile	94	17	57
Food industries	15	19	58
Beverage industries	25	21	58
Wood industries	120	16	55

Table 5 shows the comparisons of using PHPD within age and gender, which is a significant difference in two comparisons. Figure 1 Indicated that, as long as workers are older (more than 46 years old), there is a large percentage (55.42) of them reported have never used their PHPD. However, low percentages of the young worker reported that, they never used their Personal hearing protective devices.

Table4: Risk perception questionnaire and results. (Cronbach's alpha for these ten items was 0.76)

Item #	Item works	Scale		Score Mean	Item-total correlation
		% Male	% Female		
KNOWLEDGE ABOUT NOISE					
1	Exposure to high-noise levels can be dangerous For my hearing	71.0	9.8	3.15	0.45
3	Any high-noise level can be dangerous	76.0	8.2	3.16	0.53
4	It is not needed to use PHPD in my workplace	77	8.5	2.95	0.63
5	Noise can permanently affect my hearing	79.0	7.6	3.14	0.58
KNOWLEDGE ABOUT PHPD					
2	There are several types of hearing protectors	82.0	8.7	2.54	0.65
4	It is possible to reduce noise levels in my Workplace	76.5	7.6	1.75	0.45
SELF-EFFICACY					
1	I make all efforts to have PHPD always well fitted	76.0	8.5	2.23	0.55
4	I am sure that I use PHPD in an efficient way	77.4	7.6	2.10	0.63
Health &safety					
2	Do you have headache at work	82.0	3.4	3.23	0.68
3	Do you use your PHPD at all the time?	50.5	5.1	3.15	0.64

Figure 2 indicated that 10% workers are working in areas with noise level 86-90 dBA, 56.4% working in areas with noise level 91-95 dBA, and 33.6% working in areas more than 96 dBA.

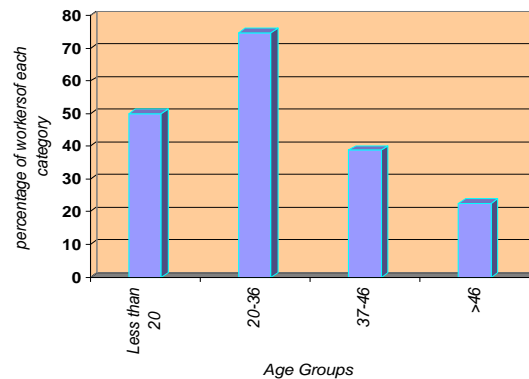


Fig 1: shows the comparison used of PHPD within different age groups

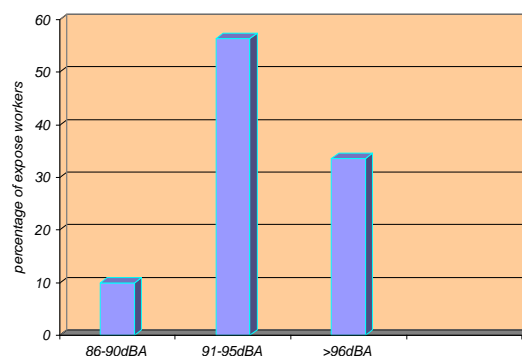


Fig 2: Percentage of exposing workers with different noise levels

Table 5: Comparisons of using PHPD within age and gender

Variable	N	PHPD use (%)
Gender		
Male	300	54.58
Female	54	89.00
Age (years)		
1) Less than 20	10	50.00
2) 20-36	102	74.80
3) 37-46	124	38.80
4) >46	118	22.64

From Figure 3 it is possible to verify that female workers trust the use of their Personal Hearing Protective Devices according to the male workers. Workers are not also familiar with the effects of high noise exposure on their hearing.

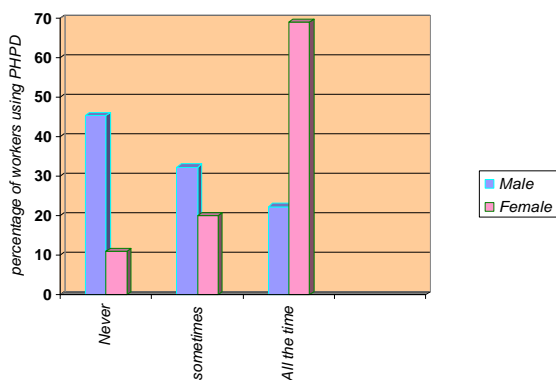
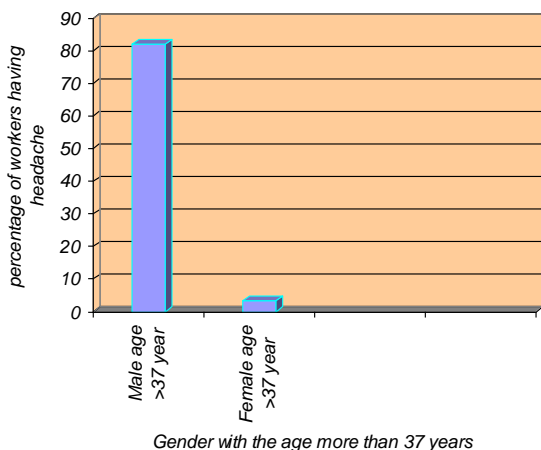
**Fig 3:** PHPD use within six groups

Figure 4 shows that male workers as long as are older (more than 37 years old), a large percentage (82) of them reported have headache at work compare to female with same age groups. It seems reasonable to assume that risk perception in workplaces can, at least to a certain extent, influence workers' behavior and thus their exposure to these risks [23].

**Fig 4:** Percentage of workers having headaches at the workplace

Self-efficiency is an important predictor of hearing protector use [24] and is likely to also determine whether people use other means to reduce their noise exposure, such as engineering, administrative or other alternate solutions to reduce noise levels at the source. Chi-square analysis indicated that the difference in use of PHPD within several categories (Table 1), namely gender ($\alpha = 0.005$), age ($K^2 = 67.65, df = 6, \alpha = 0.005$), year with industries ($K^2 = 67.65, df = 6, \alpha = 0.005$) and educational background ($K^2 = 67.65, df = 6, \alpha = 0.005$) was significant.

DISCUSSIONS

This study investigated the associations between noise exposure and the use of Personal hears protective devices in 5 different industrial companies, metal fabrication, textile, food, beverage and wood industries. These industries were located in Kerman, south-eastern in Iran. The finding of this study shown that workers are working in an area higher than the action level for daily occupational noise exposure defined in Iranian legislation (85dB (A)) for 8h/d. Analysis of the questionnaire data and table 5 indicated that, the average workers used their PHPD during almost half of the time that they were exposed to high noise levels (55.6%). Approximately 75% of the workers with age 18-36 reported the use of personal protective Devices at all the time, and 73% of workers with age more than 46 years old reported that they had never used their PHPD, even though it was mandatory in their workplaces. Finding of the study showed that only younger workers with minor professional experience and with high educational background are used PHPD to protect and preserve their hearing. Statistical data show that, the percentage of male workers (82) with age more than 37 years old having headaches at workplace are higher than female (3.4) with the same age groups. Beyond the fact that PHPD should have appropriate

attenuation characteristics to the specific noise environment in which it will be used, it is also known that some ergonomic aspects of the PHPD, such as the comfort, play an important role in the PHPD efficacy. Personal protective Devices efficacy depends largely on the use duration when exposed to noise and, consequently, on its comfort.

Melamed [8] indicated that the most significant of preventative action, particularly for the wearing of hearing protectors, is self-efficacy. Author previous work [25] indicated that, there must be a training program concerning the use of PHPD of all workers within the industries; Williams *et al.* [26] shows the overall results are positive with significant effects being generated by a very simple one-hour workshop session. An opportunity to develop and implement such workshops has the potential to increase individuals, awareness of noise as a workplace hazard. Berger [27], suggest that an additional issue in the PHPD use is the enforcement of utilization. The questionnaire was shown to be capable of reduction from 17 to 10 items while maintaining a good overall reliability rating ($\alpha = 0.76$). This makes for easier application of a Questionnaire in a workplace situation where respondent's time and patience in completing questionnaires is very important.

CONCLUSIONS

Personal hearing protective devices (PHPD) are acoustical barriers that reduce the amount of sound energy transmitted to receptors in the inner ear. Personal hearing protective devices are temporary solution. These devices are easily implemented, low-cost methods of minimizing hearing loss from continuous exposure to high-intensity noise [5, 17]. Whenever employees are exposed to excessive noise levels, feasible administrative or engineering controls should be used to

reduce these excessive sound levels. Where these control measures cannot be completely accomplished, and/or while such controls are being initiated, personnel must be protected from the effects of excessive noise levels. The results of this study indicated that employers must play an important role in promoting the regular use of Personal hearing protective devices. Individual risk perception must be considered in the Hearing Conservation Program. Women are using their personal hearing protective devices more than men. All industries surveyed are having a noise level more than 85 dBA. A noise training and education program must be developed for industrial employees in order to protect them from hazardous noises. From these results it is evident that in order to bring about more significant changes in the prevention of noise exposure in the workplace, training programs must aim at affecting more simple attitudes and perceptions. Although self-efficacy was measured at an individual level, it depends on several aspects that should be addressed when firms designed training contents. The importance of self-efficacy achieved if PHPD selection is also improved.

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